The Effect of Seasonal Temperatures on Maturity of Oats Planted at Different Dates

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The effects of environmental factors on the growth rate of plants have been observed for many years. Temperature, as it influences the plant throughout the growing season, has been the object of intensive study (5, 6, 7). Regardless of how favorable light and moisture conditions may be, a certain minimum temperature is required before any growth can take place (6). Minimum temperatures for growth vary for different species. For example, peas will germinate at 40° F. while corn requires a temperature of at least 50° F. (12). In general, the higher the temperature, up to a certain point, over the minimum required for growth, the more rapid the growth rate (2, 5). Temperatures above the optimum retard growth until finally a maximum is reached where all growth ceases.

Crops planted at weekly intervals in the early spring sometimes mature with only a 1- or 2-day differential while at other times there may be a spread of 6 to 8 days in maturity (2, 3). A "heat unit theory" was suggested about 30 years ago (2, 8) which has been revised and used successfully (1, 11) by many canning companies to determine when successive plantings should be made so as to attain a steady succession of harvests as the peas approach the desired level of maturity. A heat unit may be defined as 1 degree F. in the daily mean temperature above the minimum temperature required for growth of a particular species. In order to predict the approximate harvest date for a given crop (using the direct summation index in which it is assumed that rate of growth is directly proportional to increase in temperature) it is necessary to know approximately how many heat units must be accumulated to obtain a given maturity level. Growers may then plant enough of the crop to keep the cannery going for one day and delay successive plantings until approximately the same number of heat units accumulate as are present in a single day during the harvest season (11).

More recently the heat unit theory has been examined to determine if it might be of value to plant breeders. Corn geneticists would like to predict more accurately when inbreds and single crosses should be planted so that tasseling and silking of parents will occur at the same time. Small grain breeders may be able to use this theory in producing plants that will mature at a season of minimum insect and disease damage. It has long been known that diseases that attack small grains cause premature ripening and subsequent reduction in yield and quality of the grain (9, 10). Rust-infected plants use considerably more water per unit of dry matter than disease-free plants (9). However, such wide differences exist in the number of heat units required between lines and varieties of a given crop that much of this work is still in the developmental stage.

Several years ago as a phase of the oat breeding program at the Iowa Agricultural Experiment Station, L. C. Burnett and R. E. Atkins planted a number of oat varieties over a 6- to 8-week period to determine the effect of planting date on yield and other agronomic characters. These data, and additional results obtained in 1954 and 1955 are presented here in an attempt to answer the following questions:

1. Is it possible to use the heat unit theory to predict when different varieties of oats will come into head and reach maturity?
2. Are the same number of heat units required for each variety every year?
3. Are the same number of heat units necessary to mature each variety regardless of date of planting?

MATERIALS AND METHODS

Nine varieties of oats, Minda, Tana, Gopher, Clinton, Mohawk, Benton, Marion, Colo, and Shelby, were grown by Burnett and Atkins over a 6-year period, 1944-50. Plantings were made at 6 different dates each year, 3 in April and 3 in May—one planting date occurring sometime during each third of the month. Notes were taken on date of heading, date of maturity and yield.

In 1954 eight oat varieties, Andrew, Cherokee, Clintafe, Clinton, Ajax, Branch, Missouri 0-205, and Sauk, were sown in replicated plots as weekly intervals, starting on April 1. The last planting was delayed 10 days because of rainy weather. This experiment was repeated in 1955, starting on April 2, except for the substitution of Bonham, Clarion, and Simcoe for Clintafe, Ajax, and Branch. Data were recorded for date of emergence, heading, and maturity. Yield and plant height at maturity also were measured.

Temperature records for the period, 1944-50, were obtained from published records (13) of the local U. S. Weather Bureau Station located at the Agronomy Farm, Ames. Temperature records for 1954 and 1955 were obtained from continuous recording thermographs placed in shelters in the middle of the plot. These temperatures coincided very closely with the official temperatures obtained from the records (13) of the local U. S. Weather Bureau Station. Daily soil temperatures at a 1-inch depth at 12:00 noon, and 7:00 p.m. were recorded in 1954 and 1955 by the U. S. Weather Bureau Station. These readings were averaged daily to obtain the accumulated soil heat units, since soil temperatures generally lag from 2 to 7 degrees behind air temperatures during the spring (11).

The minimum temperature on which to base the heat unit computations was determined by laboratory germination tests. The minimum temperature for growth of oats has been defined as between 38° F. and 45° F. (4). Three varieties, Cherokee, Clintafe, and Branch, which are classed as early, medium, and late respectively, were placed in germination chambers varying by 1 degree temperature intervals within this range and left there for two weeks. Approximately 50% germination was obtained from each variety at 40° F. Germination dropped off rapidly at temperatures of less than 40° F. and less than 2% of the seed germinated at 38° F. Cherokee germinated about 3 days earlier than the others.

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